

The Examiner objected to the specification for containing informalities. In particular, the Examiner noted inconsistencies between the reference variables used in paragraph [0026] and the drawings. In response, paragraph [0026] is amended to use symbols that are consistent with Fig. 2B. The Examiner also noted incomplete or ungrammatical phrases in claim 13. The above amendment of claim 13 corrects those phrases.

Claims 1-3, 13, 14, and 15 were rejected under 35 U.S.C. § 112, second paragraph.

In regards to claim 1, the Examiner indicated that the term underfill is ambiguous because in regions not covered by the die the material is not underfilling the die. Applicants respectfully traverse the rejection of claim 1 because the term “underfill” as used in claim 1 does distinctly point out the claimed subject matter. In particular, those skilled in the art would understand that an underfill can and generally will extend beyond the boundary a die being underfilled. Applicants thus believe that the term “underfill” as recited in claim 1 meets the requirements of 35 U.S.C. § 112, second paragraph.

The Examiner indicated that claims 2, 3, 14, and 15 were unclear for failing to indicate a reference surface for the recited wetting angles. Claims 2, 3, 14, and 15 are amended to indicate reference surfaces for the wetting angles.

Claim 13 is amended to correct the incomplete phrases as noted above.

In view of the above amendments, Applicants request reconsideration and withdrawal of the rejection under 35 U.S.C. § 112.

Claims 1-4, 6-9, and 12-16 were rejected under 35 U.S.C. § 102(b) as anticipated by U.S. patent No. 5,541,450 (Jones). Applicants respectfully traverse the rejection.

Jones discloses low profile ball grid array semiconductor packages, and Fig. 5 illustrates a flip-chip embodiment of Jones’ low profile package. To achieve a low profile, Jones discloses, “A ball-grid array (BGA) semiconductor package (10,60,90) includes a substrate (31,61,91) attached to a support substrate (32,62,92). The substrate (31,61,91) has an opening (33) extending from an upper surface to a lower surface. An integrated circuit chip (18) is attached to the support substrate (32,62,92) within the opening (33). . . . The support substrate (32,62,92) provides a low profile and functions as a standoff that limits the collapse of the conductive solder balls (26) when the BGA semiconductor package (10,60,90) is attached to an application board (46).” See the abstract of Jones.

Independent claim 1 distinguishes over Jones at least by reciting, "a die ... placed so that ... metal bumps contact the conductive traces on the first face of the substrate, wherein an edge of the die overlies a portion of the ball grid array; a dam ...; and an underfill ... extending from under the die onto the first face of the substrate, wherein the dam confines and shapes an edge of the underfill." Jones fails to disclose a package where "an edge of the die overlies a portion of the ball grid array."

Further, it would not have been obvious to modify Jones so that a portion of a ball grid array underlies the edge of the die because Jones teaches that the support substrate (32, 62, 92, 122) on which the die is mounted must be "low profile." Jones provides no indication of a BGA under the support substrate. (If the low profile package could be manufactured with a BGA on the support substrate, the additional complexity required for the substrate having an opening would be unnecessary.) Jones additionally teaches away from having part of a BGA under the support substrate because Jones describes using the support substrate to limit compression of solder balls in a BGA.

As indicated in Applicants' specification, the thinning edges of underfill materials on a top surface of a substrate in a flip-chip package can warp the substrate and introduce temperature dependent stresses that make the attachment of an underlying BGA less dependable. Using a dam to shape the edge of the underfill reduces or eliminates these problems in a package where the edge of the die and/or the underfill is over the BGA. Jones fails to recognize or describe the problems solved by Applicants' invention and fails to suggest the structure now recited in claim 1.

For the above reasons, claim 1 is patentable over Jones.

Claims 2-4 and 6-8 depend from claim 1 and are patentable over Jones for at least the same reasons that claim 1 is patentable over Jones.

Claim 8 further distinguishes over Jones by reciting, "a treated region of the substrate on which a bead of the underfill resides, the underfill when liquid having a higher affinity for the treated region than for an adjacent region of the substrate so that the treated region confines and shapes the edge of the underfill." In regard to claim 8, the Examiner indicated that in Jones, "the substrate has an inherent treated region (portion of substrate that dam is formed on) that confines and shapes the edge of the underfill, therefore it inherently has a high affinity." However, Jones fails to disclose or suggest a region of higher affinity on which a bead of underfill resides.

Claim 9 distinguishes over Jones at least by reciting, "attaching the die to a substrate

so that ... an edge of the die overlies a ball grid array on a second face of the substrate; forming a dam on the first face of the substrate; and filling a volume between the die and the substrate and between the die and the dam with an underfill material."

Jones fails to disclose, "attaching the die to a substrate so that ... an edge of the die overlies a ball grid array" because to provide a low-profile package, Jones uses a low-profile support substrate (e.g., lacking a BGA) under the die. Further, modifying Jones to use a support substrate having an underlying BGA would eliminate the need for the substrate with an opening (i.e., substrate 31, 61, 91, or 121) since the BGA could be entirely on the support substrate without modifying the height of the package. Jones thus fails to suggest the combination of "attaching the die to a substrate so that ... an edge of the die overlies a ball grid array on a second face of the substrate" and "forming a dam". Accordingly, claim 9 is patentable over Jones.

Claims 12-16 depend from claim 9 and are patentable over Jones for at least the same reasons that claim 9 is patentable over Jones.

Claim 12 further distinguishes over Jones by reciting, "treating a region of the substrate so that the treated region has a higher affinity to the underfill material than does an adjacent region of the substrate, the treated region limiting flow of the underfill material during the filling. Jones fails to suggest creating regions of higher affinity to limit the flow of underfill.

For the above reasons, Applicants request reconsideration and withdrawal of this rejection under 35 U.S.C. § 102.

Claims 9, 10, and 12 were rejected under 35 U.S.C. § 102(e) as anticipated by Japanese patent publication No. 63-62362 (Inaba). Applicants respectfully traverse the rejection.

Applicants do not have an English translation of Inaba and therefore base the following comments on the figures and the English Abstract of Inaba. As indicated in the abstract, Inaba is directed to mounting of semiconductor elements on circuit substrates and particularly to simplifying the mounting process. None of the figures of Inaba show or suggest attaching a die to a substrate having an underlying BGA. As shown in Fig. 2 of Inaba, Inaba uses a dam 13 to block a packaging resin 15 that encapsulates the semiconductor element 14.

Independent claim 9 distinguishes over Inaba at least by reciting, "A method for

packaging an integrated circuit die, comprising: attaching the die to a substrate so that metal bumps on the die contact conductive traces on a first face of the substrate and an edge of the die overlies a ball grid array on a second face of the substrate ... and filling a volume between the die and the substrate and between the die and the dam with an underfill material, wherein an edge of the underfill material overlies the ball grid array." Inaba does not describe or suggest attaching a die or an underfill region with an edge overlying a ball grid array.

Inaba discloses dams 13 and 4 as respectively illustrated in Figs. 2 and 3 for packaging resin that encapsulates semiconductor elements on part of a circuit substrate. Inaba fails to suggest that such structures are suitable for controlling underfill when as indicated in Applicants' specification, the edge of the underfill can warp a BGA.

Accordingly, claim 9 and claims 10 and 16, which depend from claim 9, are patentable over Inaba, and Applicants request reconsideration and withdrawal of this rejection under 35 U.S.C. § 102.

Claims 5 and 17 were rejected under 35 U.S.C. § 103(a) as unpatentable over Jones. Applicants respectfully traverse the rejection.

Claim 5 and 17 respectively depend from claims 1 and 9, which are patentable over Jones for at least the reasons indicated above.

Claim 5 further distinguishes over Jones by reciting, "the dam has a width that is between one and two times the pitch of the ball grid array," and claim 17 further distinguishes over Jones by reciting, "the dam with a width that is between one and two times a pitch of the ball grid array on the substrate." Jones fails to disclose a dam having the recited widths.

The Examiner indicated that the recited widths "would have been an obvious matter of design choice ... because applicant has not disclosed the dimensions for a particular unobvious purpose." However, Applicants' specification at the end of paragraph [0028] and the beginning of paragraph [0029] states, "A separation greater than twice the BGA pitch ensures that stress in underfill 220 will be spread over multiple solder balls 135, and no stress concentration is within one BGA pitch. The natural performance of dam 240 is maximized when the width W of dam 240 is no less than one BGA ball pitches width." The claimed dimensions thus have the non-obvious purpose and effect of reducing stress concentrated at particular points in a BGA. Jones provides no suggestion of this purpose or effect.

For the above reasons, Applicants request reconsideration and withdrawal of the rejection claims 5 and 17 under 35 U.S.C. § 103.

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Claim 11 was rejected under 35 U.S.C. § 103(a) as unpatentable over Inaba in view of published U.S. patent application No. 2002/0053452 (Quan). Applicants respectfully traverse the rejection.

Applicants note that a copy of Quan was not included with the Office Action and that Quan is not listed on the 1449 that accompanied the application. Applicants request that Quan be included on a future 1449 for inclusion on the list of references considered by the Examiner.

Claim 11 depends from claim 9, which is patentable over Inaba for at least the reasons given above and in particular because Inaba is directed to use of a dam to control an encapsulating material and not an underfill having an edge over a BGA. Quan is directed to an encapsulation process in which “The entire array of package sites (13,14,16,21,22, and 23) is covered by an encapsulant (19). The individual package sites (13,14,16,21,22, and 23) are singulated by sawing through the encapsulant (19) and the underlying semiconductor package substrate (10).” See the Abstract of Quan. Accordingly, Inaba and Quan whether considered separately or together fail to suggest a process for “a filling a volume between the die and the substrate and between the die and the dam with an underfill material, wherein an edge of the underfill material overlies a ball grid array” as recited in claim 9. Claims 9 and 11 are thus patentable over the combination of Inaba and Quan.

For the above reasons, Applicants request reconsideration and withdrawal of the rejection under 35 U.S.C. § 103.

Claims 18-24 are added.

Claim 18 depends from claim 9 and is patentable for at least the same reasons that claim 9 is patentable.

New independent claim 19 recites, “dispensing the fill material as a liquid to fill a gap between the die and the substrate, wherein the fill material flows onto the first portion of the substrate, and the higher affinity of the first portion causes the liquid fill material to bead on the first portion of the substrate.” Claim 19 is thus patentable over the references of record because the references fail to suggest a treated portion of a substrate causing beading.

Claims 20-24 depend from claim 19 and are patentable for at least the same reasons that claim 19 is patentable.

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In summary, claims 1-17 were pending in the application. This response amends claims 1-4, 8, 9, and 12-17, and adds claims 18-24. For the above reasons, Applicants respectfully request allowance of the application including claims 1-24.

Please contact the undersigned attorney at (408) 927-6700 if there are any questions concerning the application or this document.

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Respectfully submitted,



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